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PERFORMANCE ANALYSIS OF ROTATING BIOLOGICAL CONTACTOR WITH POLYPROPYLENE AND WOOL MEDIA

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ABSTRACT

Chemical waste water from the Caprolactum plant of Fertilizers and Chemical Travancore Limited (FACT) was chosen for the treatment using Rotating Biological Contactor with polypropylene and wool as bio media. A single stage reactor with a total media surface area of 0.24m^2 was used. The detention time for each batch of treatment was selected as 3 days. The analysis was done based on the tests conducted on COD, ammonical nitrogen, pH and TSS for each batch. The analysis was done in a COD range of 500-2000 mg/L and a COD removal efficiency of 54% to 76.7% removal efficiency was observed. The study on ammonical nitrogen, TSS and pH reveals that the effluent must be further subjected to denitrification, sedimentation and pH neutralization respectively before disposal.

Key words: RBC, COD, pH, TSS, Polypropylene media, Ammoniacal Nitrogen

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1. INTRODUCTION

There is a great demand of water due to industrialization and global civilization. Due to increase in population the problem of sanitation also increases. The main source of pollution threatening to human life is due to disposal of untreated domestic wastewater to drainage systems. Therefore the safe disposal of such wastewater is considered to be the most challenging task. Pollution can be reduced by changing processing method in industry and by wastewater treatment plants. Suspended solids from the industrial wastewater are generally removed by

treatment methods such as screening, grit removal, floatation and sedimentation units but the dissolved solids must be treated physically, chemically, or biologically.

Biological waste water treatment processes are classified as either attached growth or suspended growth. In an attached growth processes, an active thin layer of microorganisms known as biofilm is developed on the solid support. Organic matter, oxygen and diffuse into biofilm where they are consumed and reacted by the living microorganisms. Attached growth process is more stable than suspended growth process. It has been found that disc biomass plays major role in organic biodegradation.

Rotating biological contactor is a conventional aerobic biological wastewater treatment unit. Conventional biological treatment means activated sludge systems and fixed film systems such as trickling filters, or RBC. The advantage of all these systems is that they are compact and that they efficiently reduce organic matter. RBC can treat domestic black or grey water and any other low or high strength biodegradable wastewater. The mechanisms of biological rotating contactors are oxygen absorption at the liquid film flowing over the discs surface during the air exposure cycle, direct oxygen transfer at the air reactor liquid interface with this diffusion being result of the turbulence created by the rotating discs and direct oxygen absorption by the microorganisms during the air exposure of the discs.

The performance of RBC systems depends on the design, temperature, concentration of pollutants, rotating velocity and hydraulic retention time of the reactor. Rotating Biological Contactors can achieve biological oxygen demand (BOD) reductions of 80 to 90%. The removal of nitrogen by nitrification and subsequent denitrification is also high, because both aerobic nitrifying bacteria and anaerobic denitrifying bacteria can simultaneously live in the attached biofilm , depending on weather they are situated on the bottom of the film, close to the disc support or at the top of the film exposed to the air. Both aerobic and anaerobic microorganisms can live in the biofilm and contribute to the removal of pollutant form the water. The biomedia used for the growth of bacterial film can be of various materials. In our study, a physical model of RBC was used to determine its performance regarding COD removal with polypropylene and wool as biomedia.

2. EXPERIMENTAL SETUP

An experimental model of RBC was set up for the treatment of effluent waste water from the caprolactum plant of Fertilizers and Chemicals Travancore Limited (FACT).RBC generally consists of closely mounted circular discs which when rotated through the wastewater at a specific rpm results in the growth of biological media on them. The required rpm will be provided using a motor. The biological media thus developed treats the waste water throughout the detention period, as a result of which the various parameters of effluent waste water like COD, pH, ammoniacal nitrogen etc. changes accordingly.

Fig 2.1. Biomedia before bacterial growth

Fig 2.2 Biomedia after bacterial growth

In the study, RBC model was set up using a plastic container of dimension 61cmx41cmx30cm.28 steel discs of 10 inch diameter and 1cm thick was mounted on a threaded mild steel shaft of diameter 12mm and 69cm long. This was rotated through the waste water in the required speed of 5rpm motor at 240V.The initial 60rpm of the motor was reduced to 5 using wheel and belt arrangement. The leather belt drive provided on the guide wheel of the motor was rotated through a wheel of 10inch diameter which in effect reduced the rpm to the required value.

Figure 2.3 Experimental setup of RBC

Polypropylene and wool was used for growing the biological media. This was mounted on the circular discs and 36% of the discs was immersed in the waste water while rotating.

3. METHODOLOGY

Influent wastewater of COD 4312mg/L was treated for 5 days for the growth of biofilm of required thickness. Organic matter present in the waste water provides the nutrients for the microbes to grow.Bio films thus developed degrade organic matter and nitrogen containing compounds in the waste water. Oxygen is obtained from the atmosphere as the pipe rotates. Waste water was treated in five separate batches of specific dilution factor which was calculated to be 3 days for each batch. Required rate of flow is maintained.Sample is collected after providing 1 day,2 day,3 day detention period.Effluent is tested for various parameters including COD, ammoniacal nitrogen, pH and total suspended solids.

4. RESULTS AND DISCUSSIONS

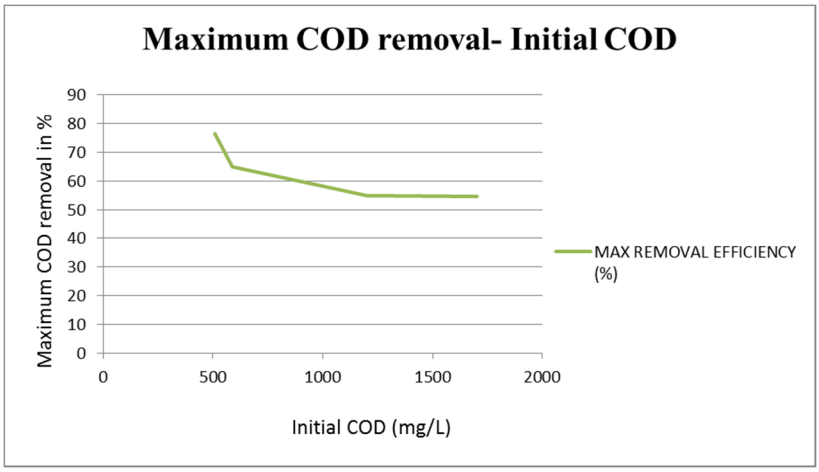

Figure 5.1maximun COD removal-initial COD

From figure 5.1, showing maximum COD removal with respect to initial COD, it is observed that generally as initial COD increases,efficiency decreases and vice versa. For batch 1and batch 2 the initial COD was increased and as a result the COD removal decreased, due to high food for micro-organisms and the micro-organisms were insuffient for the same. In batch 3 and 4 ,there is a increase in the COD removal as the initial COD was decreased and there was suffient microorganisms. When the initial COD is 509 mg/L, 76.7% maximum COD removal efficency is obtained.

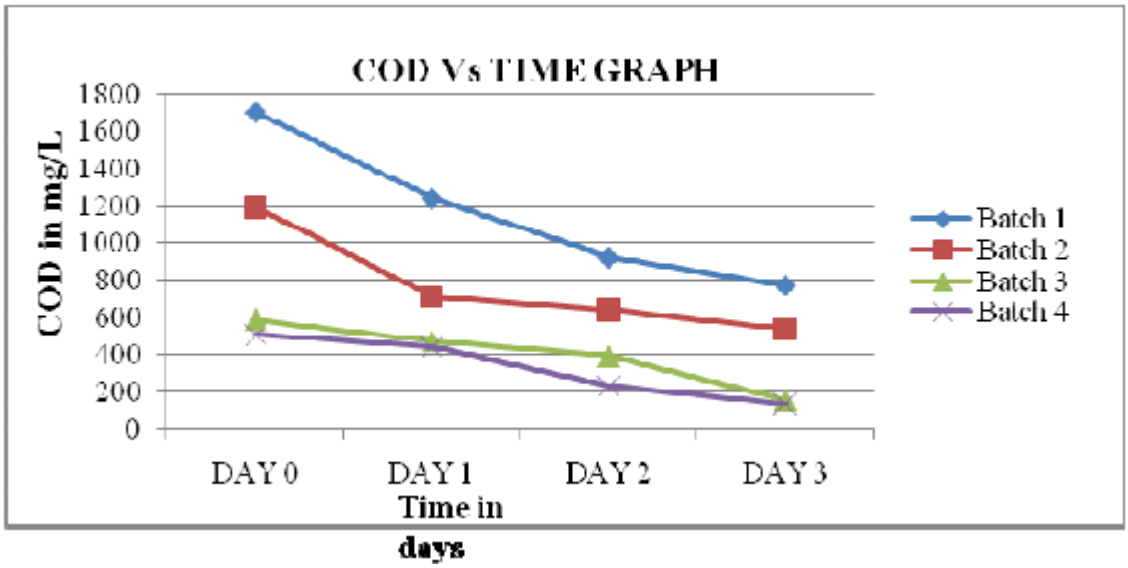

Figure 5.2 COD Vs Time

From figure 5.2, COD Vs Time graph, as detention time increases COD decreases. Initially influent COD was very high at day 0 and it reduces each day and reaches its minimum at day 3. This is due to degradation of organic matter present in water by the microorganisms present on the bio film. When lower initial COD is fed into reactor, higher COD reduction was obtained.

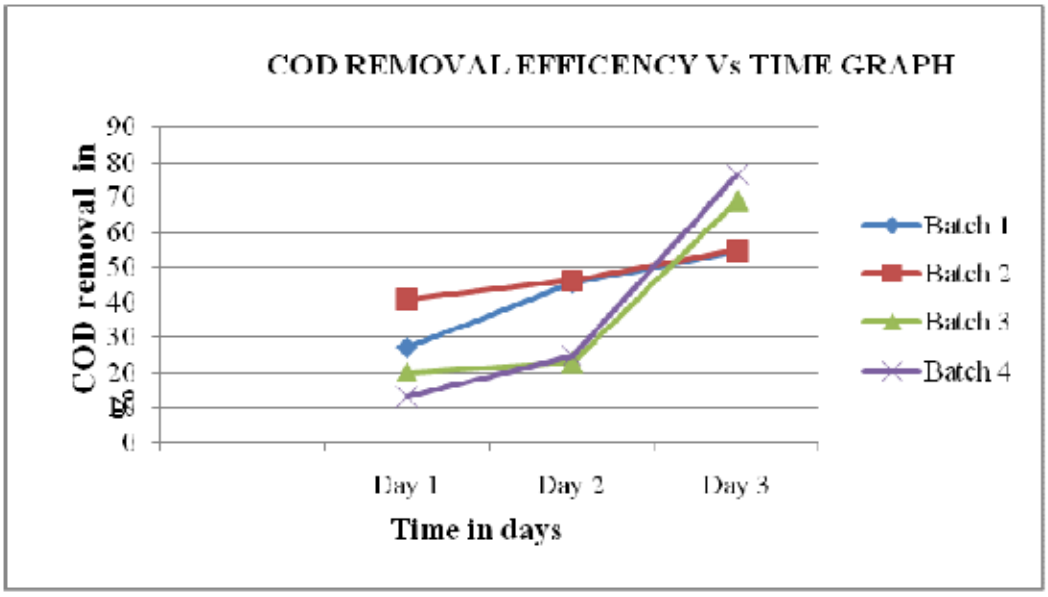

Figure 5.3 COD removal efficiency Vs Time

From figure 5.3, for COD removal efficiency Vs time graph, it was observed that higher COD removal efficiency was obtained at day 3. COD removal efficiency depends on the f/m ratio. When initial COD was less (509 mg/L) i.e., in batch 4, high removal efficiency was obtained. This is due to the fact that when initial COD decreases, food for microorganisms is less i.e., f/m ratio is less and hence the efficiency increases.

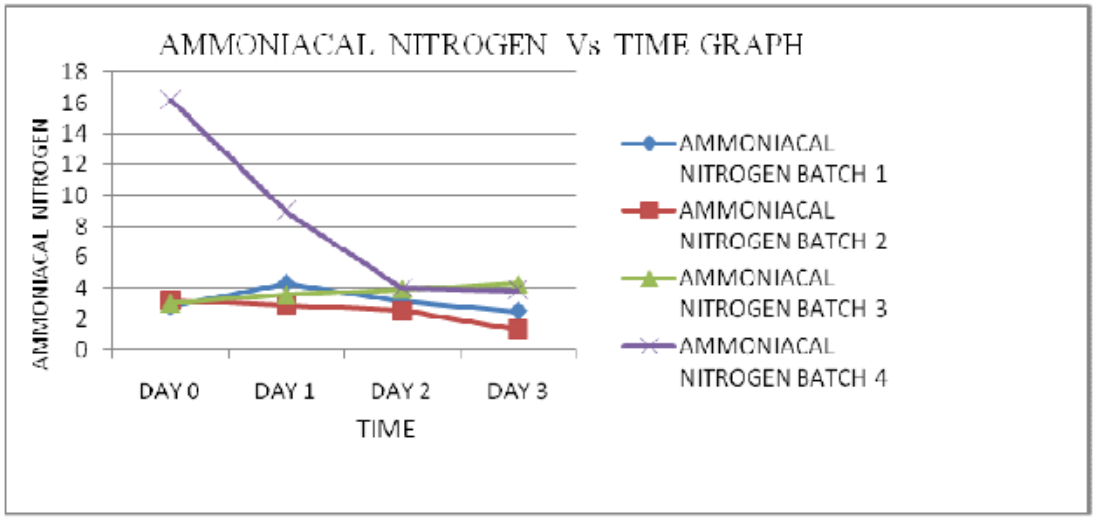

Figure 5.4 Ammoniacal Nitrogen Vs Time

From figure 5.4, for ammoniacal nitogen Vs time graph, for batch 1, 2 and 3, there was a slight increase in the value of ammoniacal nitrogen upto day 2 and thereafter it decrease .Also this variation was not uniform for all three batches. For batch 4, there was a sharp decrease from day 0 to day 3 and later it was almost steady. Hence from the grap hit can be inferred that a general trend in the variation of ammoniacal nitrogen cannot be obtained.

This may be due to the biological oxidation of organic matter. General trend in variation was that, as the pH increases ammoniacal nitrogen decreases. But due to the process of biological oxidation, sample becomes acidic. Thus there was an unpredictable change in the value of ammoniacal nitrogen with time.

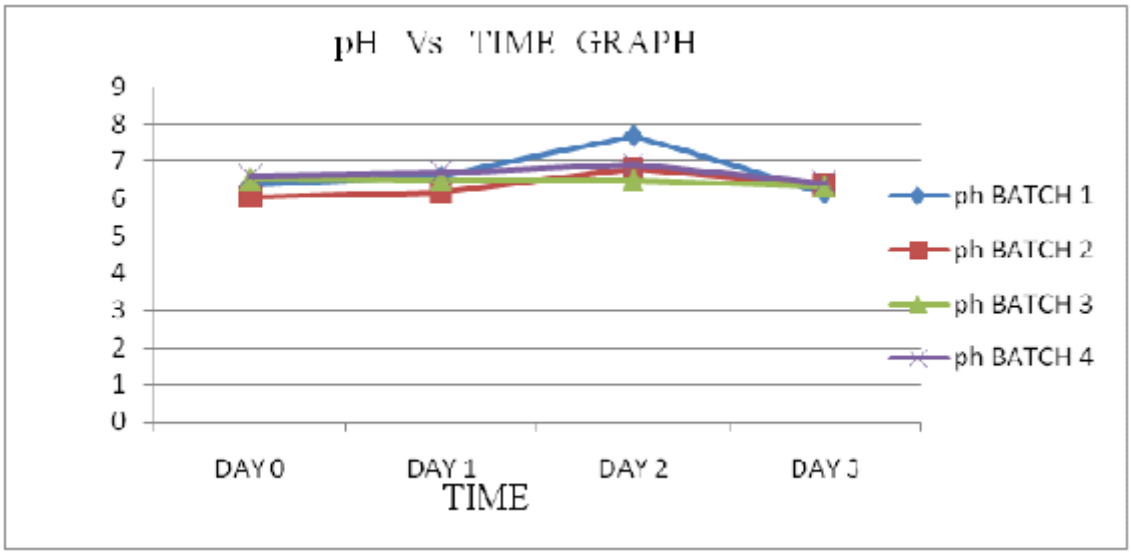

Figure 5.5 pH Vs time

From figure 5.5 for pH Vs Time, it can be seen that pH value increases from day 0 to day 2.Thereafter pH decreases gradually. This trend is followed in all the batches. The value of pH for the influent wastewater must be equal to that of the effluent wastewater. Since the detention period selected for the treatment was insufficient for the completion of methanogenesis, this condition could not be satisfied.

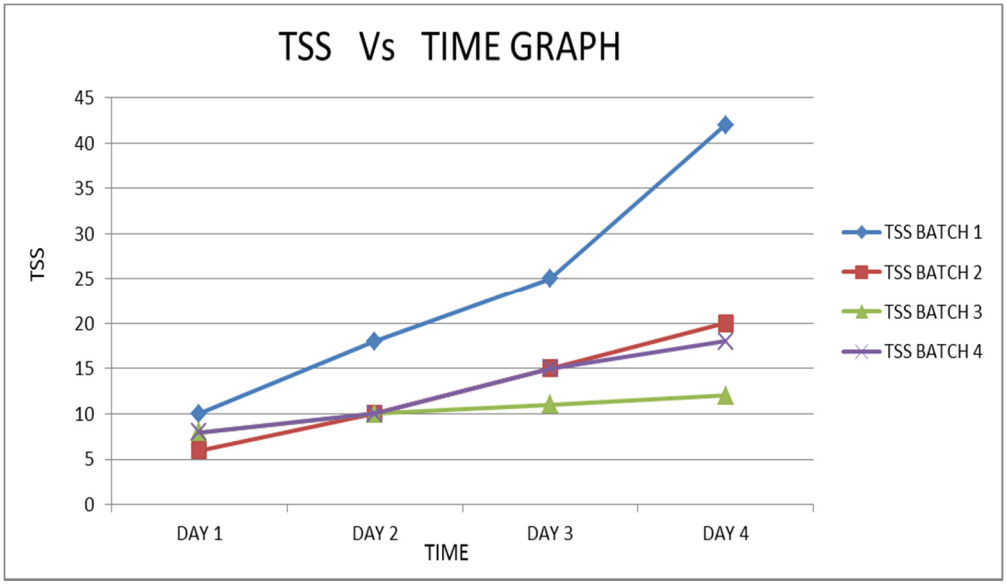

Figure 5.6 TSS Vs Time

From figure 5.6, for TSS Vs time graph ,there was an increase in the TSS. This is due to sloughing of the biofilm.Micro organisms and bacteria ,which are naturaly present in sewage,get attached to the bio media. Organic matter from the sewage also get attached to the biofilm .Outer portions forms a slim layer and the organic matter is degraded by the aerobic bacteria. As the microorganisms grow , the thickness of biofilm increases.This creates shortage of organic carbon near the media surface,due to which the microorganisms near the media surface lose the ability to cling the surface and they break up from the slim layer.

5. CONCLUSIONS

With the use of RBC, the amount of COD in the chemical waste water has reduced and the maximum removal efficiency was obtained at lower values of initial COD. When the initial COD was 1703mg/L, removal efficiency of 54.5% was obtained and when the value of initial COD was reduced by dilution to 509mg/L, removal efficiency increased to a higher value ie.76.7%.In course of time the total suspended solids (TSS) increased due to sloughing of bacterial film. The value of pH increases upto certain period and later decrease. But a general trend in the variation of ammoniacal nitrogen was not observed. With the use of polypropylene and wool as biomedia, the surface area for the growth of bacteria increased. This in effect increased the COD removal efficiency of the entire setup. Hence, from the study, polypropylene might be considered as a viable media in large scale treatment of waste water.

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